Neutrosophic Computing and Machine Learning, Vol. 28, 2023
University of New Mexico

Análisis estadístico neutrosófico del uso del ajedrez en la enfermedad de Alzheimer
Neutrosophic statistical analysis of the use of Chess in Alzheimer's disease

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Resumen. En la revisión bibliográfica se evidencia que el Ajedrez tiene potencialidades en el campo cognitivo que sirven como herramienta profiláctica para los trastornos mentales en general y la enfermedad de Alzheimer en particular, en este sentido, se requiere lograr una práctica sistemática del Ajedrez en poblaciones en riesgo presintomático con mayor énfasis en los adultos mayores. El objetivo de este trabajo es: realizar un análisis estadístico neutrosófico para identificar la efectividad de un conjunto de actividades ajedrecísticas en adultos mayores con riesgo de padecer la enfermedad de Alzheimer. Se realizó un estudio piloto de corte longitudinal y descriptivo con un período de aplicación de 12 meses donde se obtuvieron resultados positivos tras la evaluación de la memoria del adulto mayor con el Mini Examen Cognitivo, lo que permitió abrir nuevas líneas de investigación del Ajedrez en la profilaxis del Alzheimer, desde la perspectiva de la integración de las profesiones de la Cultura Física, las ciencias de la salud y los investigadores de la neutrosofía.

Palabras clave: Estadística neutrosófica, Ajedrez, Enfermedad de Alzheimer, Personas mayores

Summary. In the bibliographic review it is evident that Chess has potentialities in the cognitive field that serve as a prophylactic tool for mental disorders in general and Alzheimer's disease in particular, in this sense, it is required to achieve a systematic practice of Chess in populations at presymptomatic risk with greater emphasis on older adults. The aim of this work is: to perform a neutrosophic statistical analysis to identify the effectiveness of a set of chess activities in older adults at risk of Alzheimer's disease. A pilot study of longitudinal and descriptive cut was carried out with an application period of 12 months where positive results were obtained after the evaluation of the memory of the older adult with the Mini Cognitive Examination, which allowed opening new research lines of Chess in Alzheimer's prophylaxis, from the perspective of integration of the professions of Physical Culture, health sciences and researchers of neutrosophy.

Words key: Neutrosophic statistics, Chess, Alzheimer's disease, Older adults

1 Introducción

Chess, from its beginnings, was used as a therapeutic tool, because according to what has been said throughout the years, its origin was the result of a contest called by the King of ancient India because he was in a state of enforno and he had been advised to perform entertainment activities, this is where a Hindu created a game very similar to the current Chess called Chaturanga.

From that moment on, it has been attributed that there are countless benefits that Chess develops, either as a personality trainer or for its therapeutic potential. In the formation of the personality it has been proved that playing Chess continuously increases the intellectual abilities, develops the processes of the cognitive field, such as: attention, logical reasoning, intelligence, analysis, synthesis and creativity, among others. It organizes thinking and facilitates numerical and verbal expression [1].

In addition, the practice of this game enhances skills that are used in most spheres of social life of people such as:

- The ability to concentrate: Chess is a game in which this skill is essential to have a good performance, because the player must be attentive to the movements of the opponent and the relationships between the figures in order not to lose relevant information.
- The ability to plan: it allows to foresee the opponent's moves and plan one's own moves in order to establish a strategy that achieves the final goal.
- The ability to control: good planning always implies a good ability to control impulses, therefore, this game will encourage reflexivity against impulsivity.
- Reasoning capacity: the need to evaluate the relationships between the figures and anticipate possible moves of the opponent implies the development of a powerful abstract reasoning.
- The visuospatial perceptive capacity: the player must visualize the board as a whole, orient himself in the movement of the figures and their disposition on the board.
- The ability to relax: by applying adequate relaxation practices, the practical chess player can acquire a firm attitude, but open to the flow of ideas that will be generated during the different phases of the encounter; with the certainty that he/she will be able to face the different configurations and problems that will appear on the board in an adequate manner.

Another relevant point, although not so related to cognitive skills and common to most board games, is the understanding and respect for the limits and rules of the game, learning that should be transferred to other social games and social learning in general terms.

In addition, it is necessary to point out that positive mental states such as optimism, self-confidence, self-esteem and personal tranquility can be stimulated from a systematic practice of Chess.

Chess as a game of options and variants, where strategies and tactics are intertwined in the decision making process in order to act in a very similar way to what happens in our own personal and social life, shows how opportunities escape every day, because we simply do not have the capacity to see them because we are not trained to do so.

On the other hand, researchers suggest that paralyzing anxieties, unfounded fears and fears of various kinds have a negative influence on the central nervous system and the immune system of people. Highly stressed individuals tend to generate low levels of T and B type lymphocytes, fundamental in the defense of the organism and Chess, due to its high level of reflection and analysis, is used as a relaxing activity and as a distraction [2].

Chess nowadays favors mental health, especially now that the number of people affected by stress and Alzheimer's disease has increased. Therefore, it is necessary to look for alternatives to strengthen brain cells (neurons) in those games of wit that in ancient times gave the possibility to train human abilities [3].

There are some preventive measures for Alzheimer's disease, among them are: maintaining a healthy and active lifestyle and two fundamental directions are included: [4], [5].

The first: physical exercise, where it is recommended to perform physical activity for two hours a day, which may include walking, running, riding bicycles and some stretching exercise always under the indication of a professional who indicates them.

The second direction is cognitive activity: this is a factor that is difficult to measure. According to different studies, the following activities can "modify" in some way the onset of the disease, although further studies on these should be carried out: [4], [5]

Speaking several languages, playing musical instruments (piano, violin or guitar), reading texts of different genres, studying a career, interacting with people/participating in group activities where debate and reflection on different social, political and cultural issues prevail. Practicing with intellectual games such as chess [4], [5].

From this last idea, a bibliographic search was carried out and it was possible to contract that there have been little systematic investigations that deepen in the potentialities of Chess as a preventive tool of Alzheimer's disease, aspects that justify the need to look for new edges around the subject, where the professionals of Physical Activity in the Community from their functions and leading role they play in the community work have potentialities to work Chess with different population groups and thus contribute to prevent Alzheimer's disease.

From what has been discussed so far, it can be stated that at present it is necessary to deepen in this aspect of Chess, which has been little investigated by the Cuban and international scientific community.

In order to assess the knowledge of the Chess and Community Physical Activity teachers of the Calixto Garcia municipality, surveys and interviews were carried out, resulting in the following:

The lack of guides, manuals or brochures that allow the execution of Chess as a prophylaxis of Alzheimer's disease in older adults.

Little use of the intellectual abilities developed by Chess for the prophylaxis of Alzheimer's disease.

The use of neutrosophy for the evaluation of cognitive functions in older adults practicing Chess is scarce.

From the aforementioned evaluations, as well as the results of the diagnosis, the following problem was identified: what is the effectiveness of a set of chess activities in older adults at risk of Alzheimer's disease in Calixto

Garcia municipality, Holguin province, Cuba? In order to solve the problem, the following objective was formulated: to carry out a neutrosophic statistical analysis to identify the effectiveness of a set of chess activities in older adults at risk of Alzheimer's disease in the municipality of Calixto García, province of Holguín Cuba.

2 Metodología

2.1 Subjects under study

Neutrosophic statistics were used to calculate the study population for this research. Since the total population participating in the study is known, the neutrosophic expression p = approximate proportion of the reference population participating in the study q = proportion of the reference population that does not present the phenomenon under study (1 -p). According to criteria expressed by authors such as [6], [7], [8], [9], [10].

An important aspect in neutrosophic statistics is the identification of the desired confidence level, whose expression is (Z). It is an expression that makes evident the degree of confidence that one will have that the true value of the population found in the calculated sample. Absolute precision (d). It is the desired width of the confidence interval on both sides of the true value of the difference between the two proportions (in percentage points). N is the size of the population.

In accordance with the above, a confidence level between 90 and 95% is desired, z= [1.645, 1.96], d= [0.05, 0.1] and p = [0.4, 0.44], N=40. The result referred to as the neutrosophic sample n= [10.1, 30.6] indicates that the sample should be in values between 10 and 31 older adults.

Based on the results of the above formula, 12 older adults were selected from the Circle of Grandparents of the Circumscription two of the municipality Calixto Garcia, for their selection a simple random sampling was used, with the tombola technique. With an average age of 65.8 years, 9 of them are female and 3 are male.

2.2 Type of research

To carry out the research, a mixed methodology of both quantitative and qualitative paradigms was used, following the criteria of Valles, [11] where a pilot study was conducted with the application of a pre-test and post-test called Mini Cognitive Examination, to characterize the memory behavior of older adults before and after the application of the set of chess activities. The study lasted 12 months and the primary results obtained are evaluated for the implementation of the proposal.

2.3 Instruments

Neutrosophic method

For the neutrosophic statistical analysis developed, the workflow of four basic activities was taken into account. The statistical analysis is based on a neutrosophic environment to model uncertainty. The analysis is based on a neutrosophic statistical scheme that can address criteria of different nature in a neutrosophic environment [12]. Figure 1 shows a scheme with the activities that underlie the analysis.

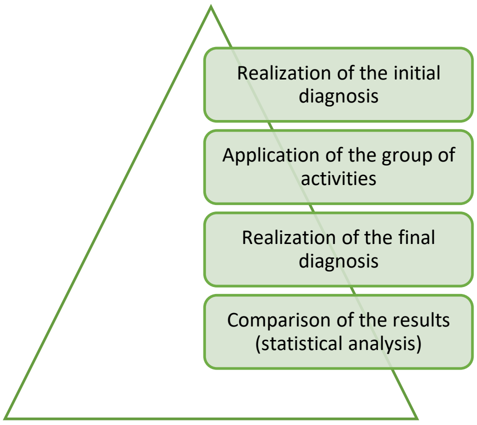


Figure 1. Neutrosophic statistical workflow.

The statistical analysis method is designed to test the effectiveness of a set of chess activities in older adults at risk for Alzheimer's disease. It is based on the following steps.

Step 1. Identify the research problem
Step 2. Bibliographic search to support the problem.
Step 3. Formulation of the objective
Step 4. Selection of the neutrosophic statistics to be applied.
Step 5. Apply the research methods
Step 6. Collection and tabulation of the data
Step 7. Analysis and interpretation of the results

The neutrosophic significance level α can be a set, not necessarily a crisp number as in classical statistics [12]. A neutrosophic P-value is defined in the same way as in classical statistics: the smallest significance level at which a null hypothesis Ho can be rejected.

The distinction between the classical P-value and the neutrosophic P-value is that the neutrosophic P-value is not a crisp number as in classical statistics, but a set (in many applications it is an interval).

In order to know the validity of the results the following was taken into account: Neutrosophic P-value = P (z < z critical value, when Ho is true). Where P (*) means classical probability calculated assuming that Ho is true, the probability of observing a test statistic value is more extreme than what was actually obtained. This has also been systematized by authors such as [12], [13], [14].

2.4 Exemplification of the set of chess activities

Based on the above, chess activities that enhance memory were used. The set of activities has three levels, proposed by [15], the first for subjects who do not master Chess at all, the second for those who know its rudiments and the third for those who master the basic techniques of Chess. In the particular case of the grandfather's circle studied, 100% of its members do not know anything about the rudiments of Chess.

Next, three of the activities contained in the set for level 1 are exemplified:

Activity 1. Recognize the Chess board by heart.

Objective: to master the main characteristics of Chess by using memory.

Guidance

The teacher explains several times how the Chess board is composed, its main rows, columns and diagonals. Then he/she places them in duo in front of a Chess board and asks them the following questions.

How many squares does the board have?

How many three-row diagonals are there?

Activity 2. Remember the pieces and their location.

Objective: to strengthen memory through the placement of positions on the board.

Guidance

The teacher places the older adults in a duo and initially places a position of three Chess pieces. It is recommended to start by placing the Knight, the Rooks and the King because of their easy visualization for recognition. Then they are given three minutes and the position is removed from the board and the following questions are asked:

How many pieces existed on the board?

Place the position that previously existed on the board?

Activity 3. The path of my pieces.

Objective: to strengthen the memory by means of the pieces' paths on the Chess board.

Orientations

The teacher places the investigated subjects in a duo and puts pieces of both sides so that they count how many moves they need to get from one move to another on the board.

The following methodological order is recommended:

Queen positions with pawns of the opposite side on the column where it is located.

Bishop positions without any other piece on the board.

Rook positions with a piece of its own side on the column where it is located.

Finally, the Knight, which is performed after having successfully achieved more than three positions with the pieces mentioned above.

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2.5 Statistical analyses applied

Descriptive statistics were used, particularly the analysis of percentages for each of the questions. In addition, inferential statistics were used, mainly the nonparametric test of signs. For which a confidence level of 95 % and a maximum error of 5 % were taken into account, considering a value of $p \leq 0.05$ as statistically significant.

3. Resultado

For the evaluation of memory, the indicators, score and evaluative scale of the Mini Cognitive Examination are assumed, as well as the fundamental ranges:

24 -30 normal.
19-24 onset dementia.
Less than 19 dementia.
Results obtained in the pre-test.

In the indicator referring to orientation, 12 older adults for 100% obtained the maximum score of 10 points, in the second indicator which is fixation, 11 older adults for 91.6%, obtained 3 points, while 1 obtained 2 points, for 8.3%, referring to the third indicator which is attention and calculation, 7 older adults for 58.3% obtained 3 points, while 2 for 16.7% obtained 2 points and the remaining 3 for 25% obtained 1 point. In the fourth indicator which is memory the 12 older adults for 100% obtained the qualification of 2 points, in the fifth indicator which is language 3 older adults obtained 4 points for 25%, while the remaining 9 older adults for 75% obtained the qualification of 3 points.

Table 1. Results of the pre-test in the selected sample.

Older Adults	INDICATORS				TOTAL	
	1	2	3	4	5	
1	10	3	3	2	4	22
2	10	3	3	2	3	21
3	10	3	3	2	4	22
4	10	3	3	2	4	22
5	10	3	3	2	3	21
6	10	3	2	2	3	20
7	10	3	1	2	3	19
8	10	3	3	2	3	21
9	10	3	2	2	3	20
10	10	3	1	2	3	19
11	10	3	2	2	3	20
12	10	3	1	2	3	19

When applying the aforementioned scale, it can be seen in the tabulation and interpretation of the results that 100% of the older adults are in the scale of beginning dementia, which reflects that they start with mild memory impairment, an aspect that makes it be within the risk factors for Alzheimer's disease, in this sense a 12-month intervention was performed by applying the set of chess activities.

Results obtained in the post-test.

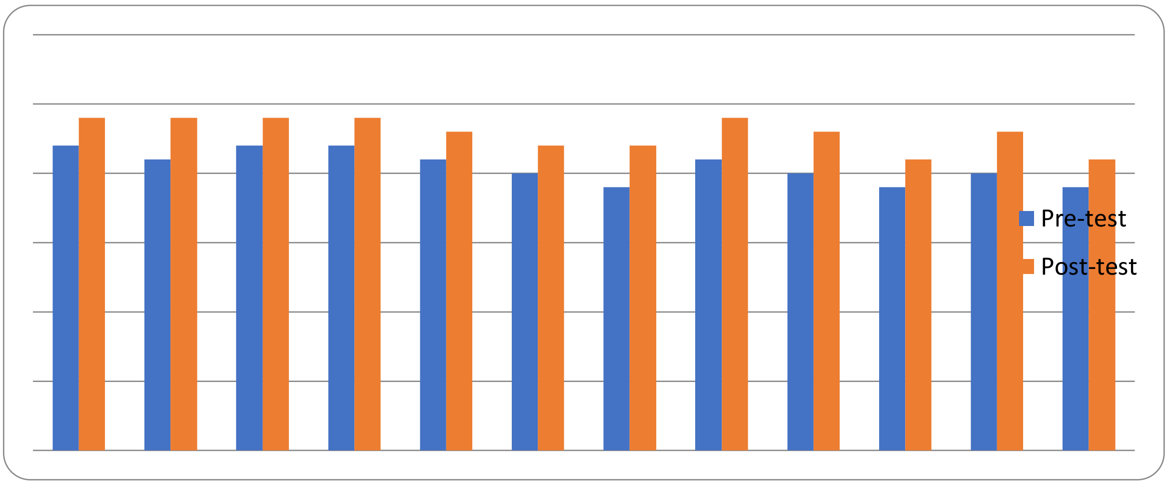
In the first indicator which is orientation, the 12 older adults for 100% obtained the maximum qualification of 10 points, in the second indicator which is fixation, the 12 older adults for 100% obtained the maximum qualification of 3 points, referred to the third indicator which is attention and calculation, 7 older adults for 58.3% obtained 4 points, 2 for 16.7% obtained 3 points and the remaining 3 for 25% obtained 2 points. The maximum score for this indicator was 5 points.

In the fourth indicator, memory, the 12 older adults (100%) obtained a score of 3 points. The maximum score for this indicator was 3 points, while in the fifth indicator, language, 7 older adults (58.3%) obtained a score of 4 points and the remaining 5 (41.7%) obtained 3 points. The maximum score for this indicator was 9 points.

Table 2. Results of the post-test in the selected sample.

Older Adults	INDICATORS					TOTAL
	1	2	3	4	5	
1	10	3	4	3	4	24
2	10	3	4	3	4	24
3	10	3	4	3	4	24
4	10	3	4	3	4	24
5	10	3	4	3	3	23
6	10	3	3	3	3	22
7	10	3	2	3	4	22
8	10	3	4	3	4	24
9	10	3	4	3	3	23
10	10	3	2	3	3	21
11	10	3	3	3	4	23
12	10	3	2	3	3	21

As shown in Figure 1, all older adults improved their memory, but it is noteworthy that a total of 5, for 41.6% of the selected sample, moved to the category of normal, the rest of the older adults (7 for 58.3%), although they increased their scores on the Mini Cognitive Test, remained in the range of beginning dementia. This has corroborated that Chess can be used as a way for the prophylaxis of Alzheimer's disease in older adults, however, this issue should be deepened in other circles of grandparents



Graph 1. Results of the pre-test and post-test comparison.

To determine the level of significance of the results obtained, the sign test was used with a binomial distribution and a significance level of 0.05, which made it possible to compare the existence of statistical differences between the pre-test and the post-test. Table 3 shows the analysis of the variation of the signs between both measurements, which allowed the procedure for the application of the test to be carried out.

Table 3. Variation of the signs between the pre-test and post-test

Older Adults	Pre-test	Pos-test	Signs
1	22	24	+
2	21	24	+
3	22	24	+
4	22	24	+
5	21	23	+
6	20	22	+
7	19	22	+
8	21	24	+
9	20	23	+
10	19	21	+
11	20	23	+
12	19	21	+

When applying the selected test to the total sample, it is obtained that all 12 signs are positive. Now, we want to test the hypothesis that the set of chess activities is a prophylactic tool to improve the signs of Alzheimer's disease. So there is a probability of obtaining a sign (-) of P = 50 against another one-sided of P 50, by calculating the mean and standard deviation of the binomial distribution following the procedure planted by Freund, [16] and applying the formula of approximation of the normal curve to the binomial distribution we obtain that: z=2. 0 and because this result exceeds the critical value of 1.64 for a one-sided test with a significance level of 0.05, we can

accept the hypothesis and affirm that the set of chess activities is a prophylactic tool to improve the signs of Alzheimer's disease.

4. Conclusión

The theoretical foundations consulted point to the importance of the use of Chess as a preventive tool for Alzheimer's disease due to its high degree of concentration, agility of thought and reflexivity.

Neutrosophic statistics is a fundamental tool to know the real effectiveness of the set of chess activities, since from the selection of the sample, to the second methodological procedures, have a high level of precision, since not only the determined but also the indeterminacy is valued.

The results obtained in this study make visible the possibility of new lines of research in this field, where Chess and neutrosophic sciences are linked to the delay of the appearance of Alzheimer's signs in older adults.

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Recibido: Mayo 13, 2023. **Aceptado:** Junio 02, 2023